analogous to connective tissue disorders. This main finding is not compromised by the heterogeneity of the literature.

The significant heterogeneity in the literature is not restricted to aortic stenosis and regurgitation, but also involves bicuspid aortic valve morphologies, as well as the nature of the underlying tissue. Indeed, we found that aortic regurgitation was reported in an older age group—had we focused on aortic valve repair publications, we would have an entirely regurgitant population subset. Similarly, had we taken a subgroup of publications from younger age groups, we would have had a stenosis-predominant subset. Only a few authors have looked at stenosis only (2), and hence, it was difficult to compare these subsets without the heterogeneity. An individual patient meta-analysis would overcome the dependence of standard meta-analysis on the case-mix of the original data, but the performance of this would require more effective data archiving than is the current practice.

We agree that the relationship of age with aortic diameter could be confounded by other factors (3,4). However, as those factors also change with age, we thought that age might be a reasonable marker to increase the clinician's alertness. We hope that once we have sufficient longitudinal data from registry studies, these relationships could be analyzed with more accuracy.

Ashutosh Hardikar, MBBS,
Thomas H. Marwick, MBBS, PhD, MPH*

*Menzies Research Institute Tasmania, Private Bag 23, Hobart, 7000, Australia. *E-mail:* *Tom.Marwick@utas.edu.au*

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Intracardiac Echo and Reduced Radiocontrast Requirements During TAVR

Acute kidney injury (AKI) is an independent predictor of mortality after transcatheter aortic valve replacement (TAVR) (1,2) and can be curbed by significantly reducing the amount of contrast agent (3). Intracardiac echocardiography (ICE) appears to match the TAVR workflow (4), provides the highest image resolution, and requires only local anesthesia. It is hypothesized that: 1) ICE is capable of effectively guiding TAVR, reducing the radiocontrast agent requirements; 2) low-contrast TAVR can minimize the risk of AKI; and 3) this strategy is safe and can improve the outcome of TAVR.

Sixty consecutive patients underwent transfemoral or transapical TAVR. In all patients, Edwards Sapien Transcatheter Heart Valves (Edwards Lifesciences, Irvine, California) were implanted. Subjects were randomized in a ratio of 1:1. In group 1, angiography served as the primary and ICE as the complementary guiding tool. In group 2, TAVR was primarily guided by ICE and complemented by angiography at the beginning of the procedure. If needed, angiography was repeated after valve deployment. Longitudinal views (4) served as primary ICE views and after deployment, short-axis views of the prosthetic valve were obtained (Online Video 1). In group 2, a pigtail catheter advanced into the noncoronary cusp identified the level of the valvular annulus. Repeat angiography was performed as needed only in group 1. AKI was graded as proposed by the Valve Academic Research Consortium (5).

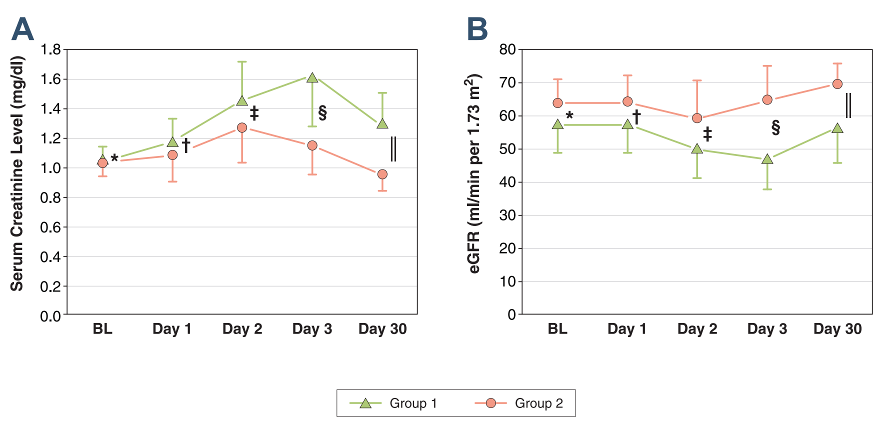

Figure 1. Thirty-Day Follow-Up of Renal Function After TAVR

(A) Serum creatinine levels and group differences on day 30: *p = 0.93, †p = 0.44, ‡p = 0.27, §p = 0.02, ‖p = 0.01, and mean Δ = −0.34 mg/dl (95% confidence interval: −5.7 to −1.6). **(B)** Estimated glomerular filtration rate (eGFR) values and group differences on day 30: *p = 0.21, †p = 0.23, ‡p = 0.18, §p = 0.01, ‖p = 0.03, and mean Δ = 13.2 ml/min per 1.73 m^2 (95% confidence interval: −5.7 to −1.6). No adjustments for multiple comparisons were made. Please see Online Videos 1 and 2. BL = baseline.

The patients represent a high-risk population (Logistic EuroSCORE 31.6 ± 13.2%, Society of Thoracic Surgeons score 12.6 ± 4.7%). Groups did not differ in terms of age, sex, operative risk scores, body mass index, comorbidities, disease-related parameters, pharmacotherapy, blood transfusion, prosthetic valve size, number of pelvic angiographies, and type of access. No patient was on long-term dialysis before the intervention. Device success was achieved in all patients without intraprocedural deaths. With 2 deaths each, 30-day mortality was not different between groups. The amount of contrast agent used was markedly lower in group 2 (72.0 ± 30.7 ml vs. 20.1 ± 8.7 ml; mean $\Delta = -51.9$ ml [95% confidence interval (CI): −60.6 to −43.3]). Post-procedural in-hospital stay was shorter in group 2 (mean $\Delta = -3.7$ days [95% CI: −5.7 to −1.6]). Creatinine levels and estimated glomerular filtration rate did not differ until days 3 and 30 (Fig. 1). Serum creatinine levels in group 1 were higher on day 3 than baseline levels (1.63 ± 0.95 mg/dl vs. 1.05 ± 0.27 mg/dl, $p < 0.001$), but not in group 2 (1.15 ± 0.55 mg/dl vs. 1.04 ± 0.28 mg/dl, $p = 0.209$). In parallel, on day 3, the estimated glomerular filtration rate was only decreased in group 1 (group 1: 47.1 ± 23.2 mg/dl vs. 57.4 ± 21.6 mg/dl, $p = 0.009$; group 2: 64.7 ± 29.8 mg/dl vs. 64.1 ± 19.0 mg/dl, $p = 0.861$). The risk of the development of stage 3 AKI was lower in group 2 (odds ratio: 0.47; 95% CI: 0.36 to 0.62). The proportion of patients with stage 0 AKI was higher in group 2 (80% vs. 63%), whereas the risk of the development of stage 2 and 3 AKI was lower (7% vs. 23%); the chi-square test for trend revealed borderline significance ($p = 0.05$). The radiocontrast volume requirement decreased to 20.1 ± 8.7 ml in group 2 (mean $\Delta = -61.9$ ml [95% CI: −70.6 to −53.3]), but the risk of procedure-related complications was not higher in this group (odds ratio: 0.46; 95% CI: 0.10 to 2.05). ICE views helped position the valve prosthesis properly (Online Video 2). The use of ICE saved 2 to 6 injections.

This study is limited by its single-center character, making the results preliminary. The present results do not apply to TAVR performed with systems other than the Edwards Sapien Transcatheter Heart Valve Systems. ICE guidance of TAVR is compatible with monitored anesthesia care in selected patients, reducing radiocontrast agent requirements, lowering the severity and probably the rate of AKI, and possibly shortening in-hospital stay after TAVR in high-risk patients.

Thomas Bartel, MD, Nikolaos Bonaros, MD, Michael Edlinger, MSc, Corinna Velik-Salchner, MD, Gudrun Feuchtner, MD, Michael Rudnicki, MD, Silvana Müller, MD*

*Division of Cardiology, Department of Internal Medicine III, Innsbruck Medical University, Anichstrasse 35, A-6020 Innsbruck, Austria. *E-mail:* *silvana.mueller@uki.at*

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APPENDIX

For supplementary videos and their legends, please see the online version of this article.

Semiautomated Quantification of Aortic Annulus Dimensions on Cardiac CT for TAVR

Computed tomography (CT) is increasingly used for prosthesis sizing in transcatheter aortic valve replacement (TAVR) because it enables 3-dimensional assessment of the complex aortic root anatomy, including the aortic annulus dimensions and the distance from the coronary artery orifices to the aortic annulus (1,2). CT can further predict appropriate C-arm angulation for orthogonal projection of the annulus plane. However, manual determination of these measurements is cumbersome and time-consuming. Alternatively, 3-dimensional cardiac CT datasets may be analyzed by automated computational algorithms (3). The aim of this investigation was to evaluate the accuracy and time-effectiveness of semiautomated model-based annulus computation compared with manual planimetry in TAVR patients.

Of 54 consecutive patients with severe symptomatic aortic stenosis and tricuspid valve anatomy undergoing dedicated electrocardiography-gated CT for TAVR planning, 4 patients were excluded due to insufficient image quality and 50 were included in this analysis (mean age 82.0 ± 5.8 years; mean aortic valve area 0.7 ± 0.2 cm^2). CT data were reconstructed at 300 ms past the R peak (section thickness, 0.6 mm) and transferred to a dedicated post-processing workstation equipped with prototype analysis software (Heart Valve Analysis Protocol, Siemens Healthcare Sector, Forchheim, Germany) on the basis of a 3-dimensional anatomic model of the aortic valve (4) (Figs. 1A to 1C). Both manual and semiautomated assessments were performed independently by 2 observers with 5 years and no experience in interpreting TAVR-planning CT studies, respectively. The inexperienced observer was trained on 10 datasets before the study. Each workflow was repeated after a 4-week interval to define intraobserver variability.

For manual assessment, CT image data were reformatted to display the aortic annulus, defined by a plane transecting the basal attachment points of the aortic cusps. Planimetry of the aortic annulus was performed by manually tracking the luminal contours, yielding the cross-sectional area (A) and perimeter (P). The area-derived diameter and perimeter-derived diameter were calculated ($D_A = 2 \times \sqrt{(A/\pi)}$ and $D_P = P/\pi$, respectively). The distance from the aortic annulus plane to the lower edge of the coronary ostia was measured in a perpendicular fashion. Finally, the corresponding cranial/caudal angulation of the